Carry
(BS/MS Version)

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Roadmap

1. What is carry?
2. Carry in different asset classes:
   - *Equity* (dividend yields)
   - *Credit* (credit spreads)
   - *Rates* (forward rates)
   - *Currencies* (rate differentials)
   - *Commodities* (convenience yields)
3. Conclude

What is Carry?

What is Carry?

- *Definition.* An asset's *carry* is the return on its "front-month" futures contract if the asset's spot price doesn't change:

$$C_0 = \frac{F_1 - F_0}{F_0} = \frac{S_1 - F_0}{F_0} = \boxed{\frac{S_0 - F_0}{F_0}} \qquad (1)$$

($F_1 = S_1$ because $t = 1$ is expiry, $S_1 = S_0$ because spot doesn't change)

- *Example.* Suppose the S&P 500 (SPX) trades at $S_0 = 7515$ and S&P 500 futures (ES) for delivery next month trade at $F_0 = 7500$:

$$C_0 = \frac{7515 - 7500}{7500} = .2\% \quad \text{(monthly)} \qquad (2)$$

- *Idea:* Carry is what you're paid (or pay) to be in a trade
- *Important!* Carry...
  - ...is **not** expected return (but it *can* be a useful clue)
  - ...does **not** require actual futures (just the no-arbitrage futures price)

What is Carry

Carry imagines the world *frozen in time*

- Short rates on various currencies stay the same
- Yield curves retain their shapes
- Futures curves for various commodities stay the same
- Equity and credit indices pay the same cash flows

Virtue: The future is cloudy, the present is clear(er)

Equities

Equities

- From Bodie/Kane/Marcus, the 1-period futures/forward price is

$$F_0 = S_0(1 + r_F - d) \tag{3}$$

where r_F is *risk-free rate*, d is *dividend yield* (derivation in appendix)

- By no-arbitrage, the futures return if the spot doesn't change is

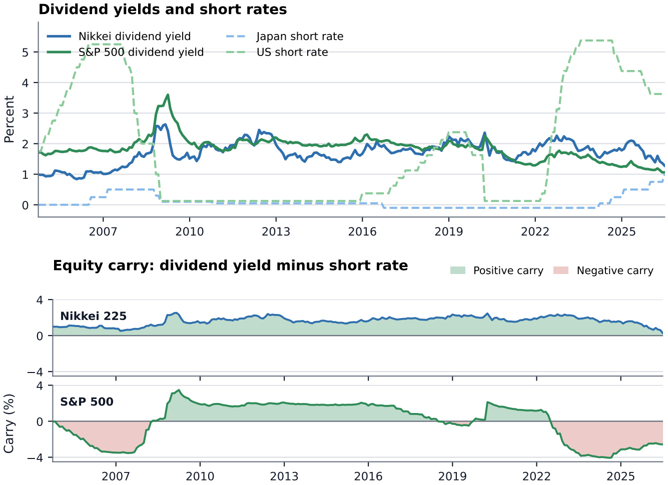
$$C_0 = \frac{S_0 - F_0}{F_0} = \frac{S_0 - S_0(1 + r_F - d)}{S_0(1 + r_F - d)} \approx d - r_F \tag{4}$$

so for equities,

$$\boxed{\text{carry} \approx \text{dividend yield} - \text{short rate}} \tag{5}$$

- Here, "short rate" is the overnight risk-free rate (e.g., SOFR)
- *Idea:* earn the dividend, pay the funding rate

Dividend Yields and Cash Rates



- Japanese equities (Nikkei 225) have had positive carry since the early aughts
- US equities (S&P 500) have experienced periods of positive, negative carry

Growth and Risk

- *Carry* doesn't require a model of asset prices
- However, a model *can* help us understand *why* carry is high/low
- Think about a stock: Using *Gordon growth* formula,

$$P_0 = \frac{D_1}{r-g} = \frac{D_1}{r_F + \pi - g}, \tag{6}$$

where π is the *risk premium* (CAPM: $\pi = \beta(\mathbb{E}(r_M) - r_F)$), therefore

$$C_0 = d - r_F = \frac{D_1}{P_0} - r_F = \pi - g \tag{7}$$

Is **carry** high because the *risk premium* π is high or *growth* g is low?

- *Example:* S&P 500 has a carry of $\approx 1\% - 3.5\% = -2.5\%$

Bull:	$\pi = 6.5\%$	and	$g = 9\%$
Base:	$\pi = 2.5\%$	and	$g = 5\%$
Bear:	$\pi = 0\%$	and	$g = 2.5\%$

Growth and Risk

	Carry is high (high dividend yield)	**Carry is low** (low dividend yield)
Growth story	• Dividends will **decelerate** • *Cheap for a reason* • **E:** U.S. banks, 2008	• Dividends will **accelerate** • *Expensive for a reason* • **E:** S&P 500, 1990s
Risk story	• Risk premium is **high** • *Investors are fearful* • **E:** GFC trough, 2009	• Risk premium is **low** • *Investors are greedy* • **E:** Dot-com peak, 2000

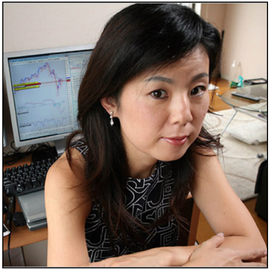
Carry is about Growth and Risk

- *Equities.* Are *dividend yields* high because
  - π: investors are worried about equity risk or
  - g: dividends growth is expected to slow?
- *Credit.* Are *credit spreads* tight because
  - π: investors are complacent about credit risk or
  - g: defaults are expected to be low?
- *Rates.* Is the *yield curve* steep because
  - π: investor are worried about inflation risk or
  - g: rates are expected to rise?
- *Currencies.* Is the *rate differential* between RBA, BOJ high because
  - π: Japanese are more risk averse than Aussies or
  - g: the AUD is expected to collapse against the JPY?
- *Commodities.* Is the WTI curve *backwardated* because
  - π: demand for physical inventory is high or
  - g: spot prices are expected to crash?

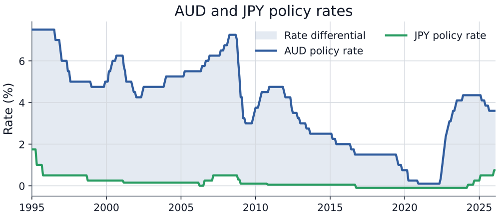
Carry is *always* about growth and risk: $\boxed{C_0 \approx \pi - g}$ (derivation in appendix)

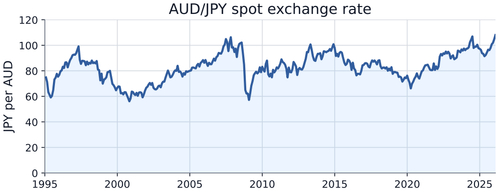
Currencies

AUD/JPY carry trade



Japanese retail traders like Mayumi Torii (above) became active in FX markets, selling the yen and buying foreign currencies. They earned the nickname "Mrs. Watanabe."





- Despite the rate differential, AUD did not fall against JPY…it rose
- The *yen carry trade* is the canonical carry trade

Currencies

- r_f is the foreign rate (Australia), r_d is the domestic rate (Japan)
- S_0 is the spot price of the AUD/JPY (say, 115 JPY)
- The forward price of the AUD/JPY is

$$F_0 = S_0(1 + r_d - r_f) \tag{8}$$

(derivation in appendix)

- Therefore, the carry is

$$C_0 = \frac{S_0 - F_0}{F_0} = \frac{S_0 - S_0(1 + r_d - r_f)}{S_0(1 + r_d - r_f)} \approx r_f - r_d \tag{9}$$

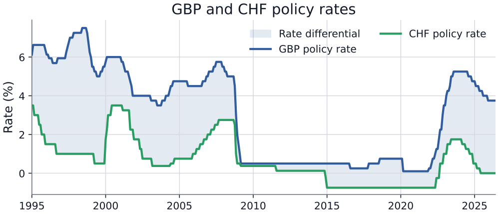
so

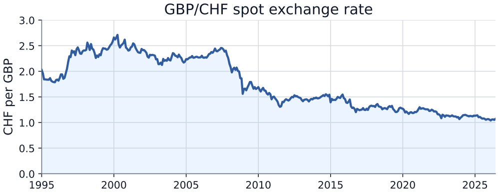
$$\boxed{\text{carry} \approx \text{rate differential}} \tag{10}$$

- *Idea:* earn the foreign rate, pay the domestic rate

GBP/CHF carry trade

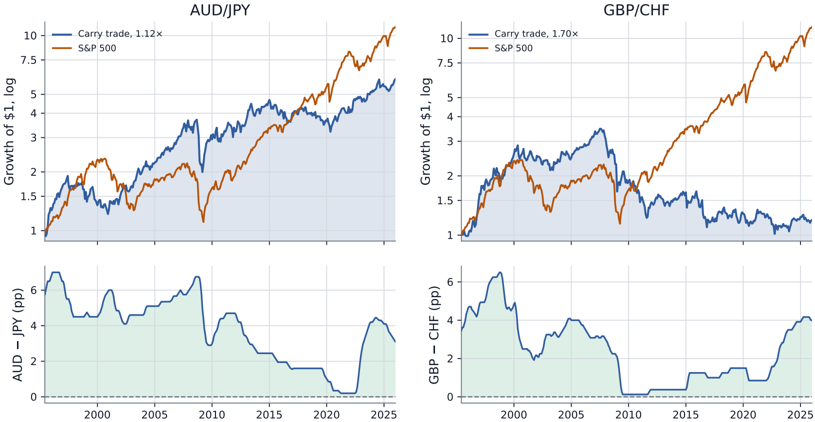
Sterling paid a *rate premium* over the franc averaging 3.9% before the crisis, but the *pound* fell from 2.7 francs in 2000 to 1.1 today. Same trade as Mrs. Watanabe's, opposite outcome.





- GBP earned a rate premium over CHF, but exchange-rate moves dominated
- Carry failed because sterling depreciation more than offset the differential

Carry and Realized Returns: AUD/JPY vs. GBP/CHF



- Both differentials were positive in all months
- Vol-matched to S&P 500: AUD/JPY returned 6.0%/yr, GBP/CHF 0.6%/yr

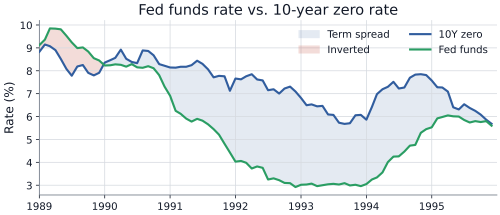
Growth and Risk

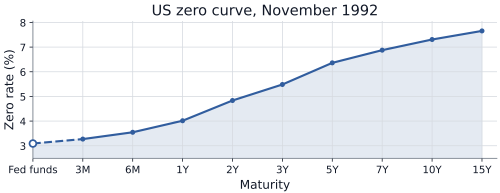
	Carry is high (positive rate differential)	**Carry is low** (negative rate differential)
Growth story	• High-rate currency **falls** • *...offsets positive carry* • **E:** GBP/CHF, 2008	• Low-rate currency **rises** • *...offsets negative carry* • **E:** JPY, 2008
Risk story	• Crash risk is **expensive** • *Market worried* • **E:** AUD/JPY, 2008	• Crash risk is **cheap** • *Market complacent* • **E:** G10 FX, 2017


Rates

Steinhardt and "Hurricane Greenspan"

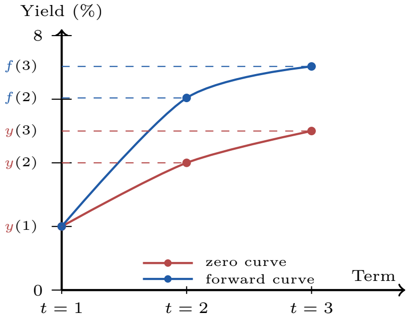
Michael Steinhardt's fund earned 47% in 1991, 48% in '92, and 60% in '93 *selling* the short-end and *buying* the long-end. He then lost 30% in '94 and shutdown the fund in '95.





- At its peak, the spread was 4.22% (7.31% vs. 3.09%)
- The trade slowly collapsed as Greenspan begun raising rates in 1994

Forward Rates on a Frozen Curve



- Freeze the yield curve
- The one-year return from holding the 3-year bond is

$$\frac{P(2)-P(3)}{P(3)} = f(3) \tag{11}$$

- The one-year return from holding the 2-year bond is

$$\frac{P(1)-P(2)}{P(2)} = f(2) \tag{12}$$

$$P(3) = (1+y(3))^{-3} = (1+f(1))^{-1}(1+f(2))^{-1}(1+f(3))^{-1} \tag{13}$$

$$P(2) = (1+y(2))^{-2} = (1+f(1))^{-1}(1+f(2))^{-1} \tag{14}$$

$$P(1) = (1+y(1))^{-1} = (1+f(1))^{-1} \tag{15}$$

forward rates are the marginal rates that compound to the zero rates

Rates

- The price of the ZCB is

$$P_0(\tau) = (1 + y_0(\tau))^{-\tau} \tag{16}$$

- The futures/forward price is

$$F_0 = P_0(\tau)(1 + r_F) \tag{17}$$

(derivation in appendix)

- The forward rate is

$$f_0(\tau) = \frac{P_0(\tau - 1) - P_0(\tau)}{P_0(\tau)} \tag{18}$$

- Therefore,

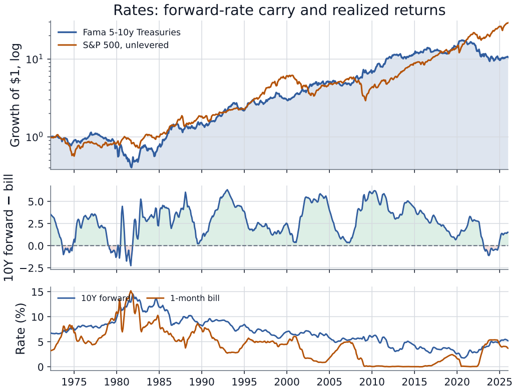
$$C_0 = \frac{S_0 - F_0}{F_0} = \frac{P_0(\tau - 1) - P_0(\tau)(1 + r_F)}{P_0(\tau)(1 + r_F)} \approx f_0(\tau) - r_F \tag{19}$$

since the spot price is $P_0(\tau - 1)$, so

$$\boxed{\text{carry} \approx \text{forward rate} - \text{short rate}} \tag{20}$$

Carry and Realized Returns: The U.S. 10-Year

This carry trade has worked surprisingly well, with brief setbacks due to shocks to inflation expectations.



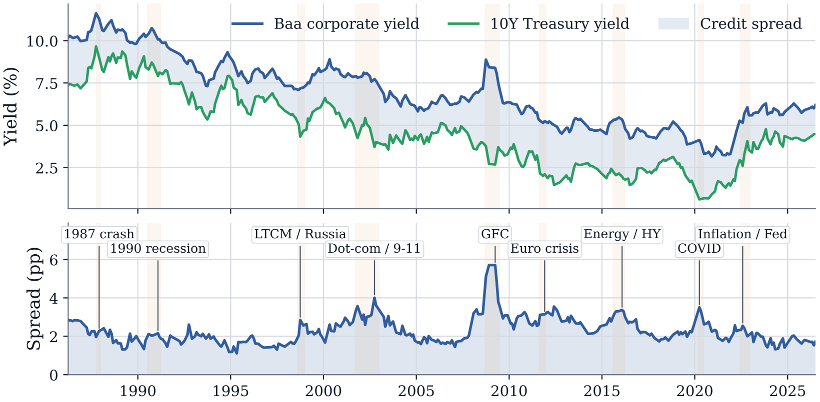
- Carry *positive* 90% of time, earning 2.6%; the *negative* 10% lost 2.4%
- Vol-matched to S&P 500: 5–10-year Treasuries returned 4.5%/yr over cash

Growth and Risk

	Carry is high (yield curve is steep)	**Carry is low** (yield curve is flat/inverted)
Growth story	• Short rates will **rise** • *Curve prices rate hikes* • **E:** U.S., 2021	• Short rates will **fall** • *Curve prices rate cuts* • **E:** U.S., 2007
Risk story	• Term premium is **high** • *Duration is cheap* • **E:** Bond selloff, 1994	• Term premium is **low** • *Duration is expensive* • **E:** Bunds, 2016


Credit

Credit Spreads and the History of the Market



- Graham and Dodd called bond selection the “negative art”
- Greater emphasis placed on avoiding losers than missing out on winners

(Duration-Hedged) Credit

- Add the *z-spread* z_0 (IG/HY, AAA/BBB/CCC):

$$B_0(\tau) = (1 + y_0(\tau) + z_0)^{-\tau} \tag{21}$$

- The duration hedged futures/forward price is

$$F_0 = \frac{B_0(\tau)}{P_0(\tau)} \tag{22}$$

- The forward rate (for this credit curve) is

$$f_0(\tau) = \frac{B_0(\tau-1)/P_0(\tau-1) - B_0(\tau)/P_0(\tau)}{B_0(\tau)/P_0(\tau)} \tag{23}$$

- By no-arbitrage, the futures return if the spot doesn't change is

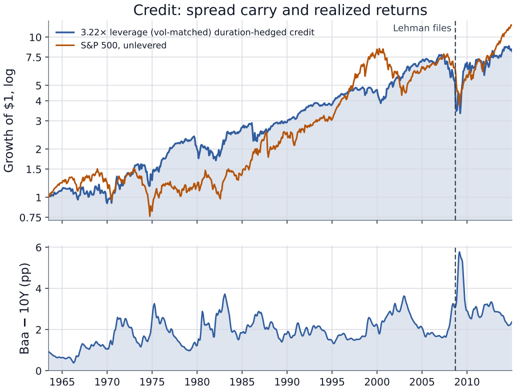
$$C = \frac{F_1 - F_0}{F_0} = \frac{B_0(\tau-1) - B_0(\tau)(1+r)}{B_0(\tau)(1+r)} \approx z_0 \tag{24}$$

having used $F_1 = B_1(\tau-1)/P_1(\tau-1) = B_0(\tau-1)/P_1(\tau-1)$, so

$$\boxed{\text{carry} \approx \text{credit spread}} \tag{25}$$

Carry and Realized Returns: U.S. Investment Grade

Lehman Brothers filed on Sept. 15, 2008. The Baa spread went from 3.3% that August to 6.0% in December, and duration-hedged credit lost 9.5% in September alone.



Source: AQR, FRED

- Vol-matched to S&P 500: 4.2%/yr over cash, vs. 4.9% for S&P 500
- Compensation for *credit events*: 57% drawdown in March 2009

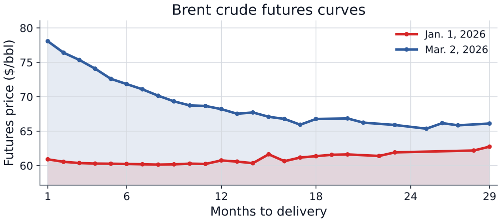
Growth and Risk

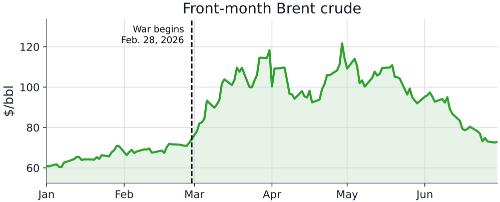
	Carry is high (credit spreads are wide)	**Carry is low** (credit spreads are tight)
Growth story	• Defaults will **rise** • *Spreads cover losses* • **E:** GFC, 2008	• Defaults stay **low** • *Balance sheets strong* • **E:** Credit expansion, 2017
Risk story	• Credit premium is **high** • *Investors worried* • **E:** COVID panic, 2020	• Credit premium is **low** • *Investors complacent* • **E:** Credit boom, 2007

Commodities

Commodities

On February 28, 2026, U.S. and Israeli forces struck Iran. Iran responded by largely closing the Strait of Hormuz, disrupting oil shipments and sending crude prices sharply higher.





- Curve began 2026 in contango, flipped into *backwardation* by start of war
- A fixed six-month Brent position gained 19.5% over the next three months

Commodities

- *Convenience yield* is an implied return on holding inventories
- The futures/forward price is

$$F_0 = S_0(1 + r_F - u) \tag{26}$$

where u is the (*net*) *convenience yield.*

- By no-arbitrage, the futures return if the spot doesn't change is

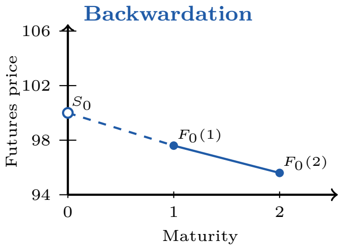
$$C_0 = \frac{F_1 - F_0}{F_0} = \frac{S_1 - S_0(1 + r_F - u)}{S_0(1 + r_F - u)} \approx u - r_F \tag{27}$$

which is the *net convenience yield*

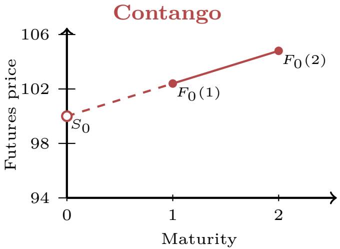
$$\boxed{\text{carry} \approx \text{net convenience yield}} \tag{28}$$

- *Problem*: Convenience yields are not directly observable
- *Solution*: Use the "futures curve"

Commodities



A downward-sloping curve has $F_0(1) > F_0(2)$: the curve is *backwardated*, basis is negative, and carry is positive.

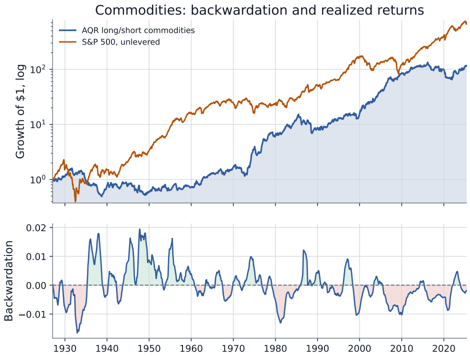


An upward-sloping curve has $F_0(1) < F_0(2)$: the curve is in *contango*, basis is positive, and carry is negative.

$$\begin{aligned} F_0(1) &= S_0(1 + r_F - u) \\ F_0(2) &= S_0(1 + r_F - u)^2 \end{aligned} \implies u - r_F = \frac{F_0(1) - F_0(2)}{F_0(1)} \tag{29}$$

Carry and Realized Returns: U.S. Commodity Basket

Commodity trading firms like Cargill arbitrage the spot and futures markets: they own the storage, the elevators, and the ships, so they can buy physical grain, sell the futures, and collect the *convenience yield* that shows up as backwardation on the curve.



Source: AQR

- *Backwardated* commodities beat those in *contango* by 5.6% per year
- At S&P-matched volatility, the trade earned only 4.9% per year over cash since 1927, versus 6.9% for the S&P 500

Growth and Risk

	Carry is high (futures are backwardated)	**Carry is low** (futures are in contango)
Growth story	• Spot prices will **fall** • *Today's shortage will ease* • **E:** Brent, March 2026	• Spot prices will **rise** • *Today's glut will clear* • **E:** Oil, April 2020
Risk story	• Convenience yield is **high** • *Fear about inventory* • **E:** European gas, 2022	• Convenience yield is **low** • *Confidence in inventory* • **E:** Oil glut, 2016

Conclusion

Conclusion

- *Carry* is
  1. the return you earn if the world doesn't change (observable!)
  2. risk premium minus growth
- It is a *model-free* measure observable from the data
- Fundamentally, a trader must use *carry* together with her own judgement to determine the direction of prices
- *Carry* unifies dividend yields, rate differentials, forward rates, credit spreads, convenience yields into a single measure
- Although "carry trades" have worked historically, they are risky for the growth vs. risk issue we have discussed

Appendix

Growth and Risk

- This decomposition is general
- The futures return is the return on the asset in excess of the risk-free:

$$(1 + R - r_F) = \frac{F_1}{F_0} = \frac{S_1}{F_0} = \frac{S_0}{F_0} \cdot \frac{S_1}{S_0} = (1 + C_0)\left(1 + \frac{S_1 - S_0}{S_0}\right) \tag{30}$$

- Recall that $\pi = \mathbb{E}[R - r_F]$ and let

$$g = \mathbb{E}\left[\frac{S_1 - S_0}{S_0}\right] \tag{31}$$

from which we conclude that

$$\boxed{C_0 \approx \pi - g} \tag{32}$$

- Carry is difference between risk-premium and growth of asset price

Appendix: Equity index forward

Security	CF_0	CF_1
Long forward on stock index	0	$S_1 - F_0$
Long stock index	$-S_0$	$S_1 + D_1$
Borrow at risk-free rate	$+S_0$	$-S_0(1 + r_F)$
Net replicating portfolio	0	$S_1 + D_1 - S_0(1 + r_F)$

Under no arbitrage, forward and replicating portfolio have same payoff:

$$S_1 - F_0 = S_1 + D_1 - S_0(1 + r_F)$$

$$\boxed{F_0 = S_0(1 + r_F) - D_1 = S_0(1 + r_F - d)}$$

Appendix: Currency forward

Security	CF_0	CF_1
Long FX forward	0	$S_1 - F_0$
Buy foreign money-market claim	$-\dfrac{S_0}{1+r_f}$	S_1
Borrow domestic money-market claim	$+\dfrac{F_0}{1+r_d}$	$-F_0$
Net replicating portfolio	$-\dfrac{S_0}{1+r_f} + \dfrac{F_0}{1+r_d}$	$S_1 - F_0$

Under no arbitrage, replicating portfolio has zero initial cost:

$$0 = -\frac{S_0}{1+r_f} + \frac{F_0}{1+r_d}$$

$$\boxed{F_0 = S_0 \frac{1+r_d}{1+r_f} \approx S_0(1 + r_d - r_f)}$$

Appendix: Rates forward

Security	CF_0	CF_1
Long forward on τ-period zero-coupon bond (ZCB)	0	$P_1(\tau-1)-F_0$
Long τ-period ZCB	$-P_0(\tau)$	$P_1(\tau-1)$
Borrow at risk-free rate	$+P_0(\tau)$	$-P_0(\tau)(1+r_F)$
Net replicating portfolio	0	$P_1(\tau-1)-P_0(\tau)(1+r_F)$

Under no arbitrage, forward and replicating portfolio have same payoff:

$$P_1(\tau-1)-F_0 = P_1(\tau-1)-P_0(\tau)(1+r_F)$$

$$\boxed{F_0 = P_0(\tau)(1+r_F)}$$

Appendix: Credit forward

Security	CF_0	CF_τ
Long forward into credit payoff	0	$X_\tau - F_0$
Long credit ZCB	$-B_0(\tau)$	X_τ
Short F_0 Treasury ZCBs	$+F_0 P_0(\tau)$	$-F_0$
Net replicating portfolio	$-B_0(\tau) + F_0 P_0(\tau)$	$X_\tau - F_0$

Under no arbitrage, replicating portfolio has zero initial cost:

$$0 = -B_0(\tau) + F_0 P_0(\tau)$$

$$\boxed{F_0 = \frac{B_0(\tau)}{P_0(\tau)}}$$

Appendix: Commodity forward

Security	CF_0	CF_1
Long commodity forward	0	$S_1 - F_0$
Long physical commodity	$-S_0$	$S_1 + U$
Borrow at risk-free rate	$+S_0$	$-S_0(1 + r_F)$
Net replicating portfolio	0	$S_1 + U - S_0(1 + r_F)$

Under no arbitrage, forward and replicating portfolio have same payoff:

$$S_1 - F_0 = S_1 + U - S_0(1 + r_F)$$

$$\boxed{F_0 = S_0(1 + r_F) - U = S_0(1 + r_F - u)}$$